ANTI-REWET PRESS FABRIC OR FILTER MEDIA COMPRISING A FINE POROUS LAYER OF SPLITTABLE MIRCOFIBERS

Background of the Invention

Field of the Invention

The present invention relates to industrial fabrics for the papermaking arts. More specifically, the present invention relates to press fabrics for the press section of a paper machine. In addition, the present invention relates to filtration fabrics.

Description of the Related Art

During the papermaking process, a cellulosic fibrous web is formed by depositing a fibrous slurry, that is, an aqueous dispersion of cellulose fibers, onto a moving forming fabric in the forming section of a paper machine.

A large amount of water is drained from the slurry through the forming fabric, leaving the cellulosic fibrous web on the surface of the forming fabric.

The newly formed cellulosic fibrous web proceeds from the forming section to a press section, which includes a series of press nips. The cellulosic fibrous web passes through the press nips supported by a press fabric, or, as is often the case, between two such press fabrics. In the press nips, the cellulosic fibrous web is subjected to compressive forces which squeeze water therefrom, and which adhere the cellulosic fibers in the web to one another to turn the cellulosic fibrous web into a paper sheet. The water is accepted by the press fabric or fabrics and, ideally, does not return to the paper sheet.

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The paper sheet finally proceeds to a dryer section, which includes at least one series of rotatable dryer drums or cylinders, which are internally heated by steam. The newly formed paper sheet is directed in a serpentine path sequentially around each in the series of drums by a dryer fabric, which holds the paper sheet closely against the surfaces of the drums. The heated drums reduce the water content of the paper sheet to a desirable level through evaporation.

It should be appreciated that the forming, press and dryer fabrics all take the form of endless loops on the paper machine and function in the manner of conveyors. It should further be appreciated that paper manufacture is a continuous process which proceeds at considerable speeds. That is to say, the fibrous slurry is continuously deposited onto the forming fabric in the forming section, while a newly manufactured paper sheet is continuously wound onto rolls after it exits from the dryer section.

The present invention relates to the press fabrics used in the press section. Press fabrics play a critical role during the paper manufacturing process. One of their functions, as implied above, is to support and to carry the paper product being manufactured through the press nips.

Press fabrics also participate in the finishing of the surface of the paper sheet. That is, press fabrics are designed to have smooth surfaces and uniformly resilient structures, so that, in the course of passing through the press nips, a smooth, mark-free surface is imparted to the paper.

Traditionally, press sections have included a series of nips formed by pairs of adjacent cylindrical press rolls. In recent years, the use of long press nips of the shoe type has been found to be more advantageous than the use of nips formed by pairs of adjacent press rolls. This is because the web takes longer to pass through a long press nip than through one formed by press rolls. The longer the time a web can be subjected to pressure in the nip, the more water can be removed there, and, consequently, the less water will remain behind in the web for removal through evaporation in the dryer section.

Perhaps most importantly, the press fabrics accept the large quantities of water extracted from the wet paper in the press nip. In order to fulfill this function, there literally must be space, commonly referred to as void volume, within the press fabric for the water to go, and the fabric must have adequate permeability to both water and air for its entire useful life. Finally, press fabrics must be able to prevent the water accepted from the wet paper from returning to and rewetting the paper upon exit from the press nip.

Contemporary press fabrics are produced in a wide variety of styles designed to meet the requirements of the paper machines on which they are installed for the paper grades being manufactured. Generally, they comprise a woven base fabric into which has been needled a batt of fine, nonwoven fibrous material. The base fabrics may be woven from monofilament, plied monofilament, multifilament or plied multifilament yarns, and may be single-layered,

multi-layered or laminated. The yarns are typically extruded from any one of the synthetic polymeric resins, such as polyamide and polyester resins, used for this purpose by those of ordinary skill in the paper machine clothing arts.

The woven base fabrics themselves take many different forms. For example, they may be woven endless, or flat woven and subsequently rendered into endless form with a woven seam. Alternatively, they may be produced by a process commonly known as modified endless weaving, wherein the widthwise edges of the base fabric are provided with seaming loops using the machine-direction (MD) yarns thereof. In this process, the MD yarns weave continuously back-and-forth between the widthwise edges of the fabric, at each edge turning back and forming a seaming loop. A base fabric produced in this fashion is placed into endless form during installation on a paper machine, and for this reason is referred to as an on-machine-seamable fabric. To place such a fabric into endless form, the two widthwise edges are brought together, the seaming loops at the two edges are interdigitated with one another, and a seaming pin or pintle is directed through the passage formed by the interdigitated seaming loops.

Further, the woven base fabrics may be laminated by placing at least one base fabric within the endless loop formed by another, and by needling a staple fiber batt through these base fabrics to join them to one another. One or more of these woven base fabrics may be of the on-machine-seamable type. This is now a well known laminated press fabric with a multiple base support structure.

In any event, the woven base fabrics are in the form of endless loops, or are seamable into such forms, having a specific length, measured longitudinally therearound, and a specific width, measured transversely thereacross. Because paper machine configurations vary widely, paper machine clothing manufacturers are required to produce press fabrics, and other paper machine clothing, to the dimensions required to fit particular positions in the paper machines of their customers. Needless to say, this requirement makes it difficult to streamline the manufacturing process, as each press fabric must typically be made to order.

In response to this need to produce press fabrics in a variety of lengths and widths more quickly and efficiently, press fabrics have been produced in recent years using a spiral technique disclosed in commonly assigned U.S. Patent No. 5,360,656 to Rexfelt et al., the teachings of which are incorporated herein by reference.

U.S. Patent No. 5,360,656 shows a press fabric comprising a base fabric having one or more layers of staple fiber material needled thereinto. The base fabric comprises at least one layer composed of a spirally wound strip of woven fabric having a width which is smaller than the width of the base fabric. The base fabric is endless in the longitudinal, or machine, direction. Lengthwise threads of the spirally wound strip make an angle with the longitudinal direction of the press fabric. The strip of woven fabric may be flat-woven on a loom which is narrower than those typically used in the production of paper machine clothing.

The base fabric comprises a plurality of spirally wound and joined turns of the relatively narrow woven fabric strip. The fabric strip is woven from lengthwise (warp) and crosswise (filling) yarns. Adjacent turns of the spirally wound fabric strip may be abutted against one another, and the helically continuous seam so produced may be closed by sewing, stitching, melting or welding. Alternatively, adjacent longitudinal edge portions of adjoining spiral turns may be arranged overlappingly, so long as the edges have a reduced thickness, so as not to give rise to an increased thickness in the area of the overlap. Further, the spacing between lengthwise yarns may be increased at the edges of the strip, so that, when adjoining spiral turns are arranged overlappingly, there may be an unchanged spacing between lengthwise threads in the area of the overlap.

In any event, in the press section of the papermaking machine, the formed sheet is pressed to a higher dry content through consecutive press nips. The sheet is carried through the press nip together with one or several endless textile fabrics, that are commonly referred to as press fabrics.

The paper web, or sheet, and press fabric probably reach minimum thickness at the same time somewhat near mid nip. The sheet is considered to reach its maximum dry content at the very same moment. After that, the sheet, as well as the fabric, begin to expand. During this expansion, a vacuum is created in the paper web and in the surface layer of the press fabric, both of which have been compressed to a minimum thickness at a maximum pressure. In

response to this vacuum, water flows back from the inside and possibly base layers of the fabric to the surface layer of the fabric and into the paper sheet to reestablish the pressure balance. This expansion phase provides the driving force of the rewetting of the paper sheet inside the press nip.

Another factor that is important in press fabrics is the amount of time required before the press fabric reaches its maximum ability to extract water from the paper web (i.e., dewater the paper sheets) after the press fabric is newly installed in the paper machine. This time period is termed "start-up" period for the press fabric. This period may last from a couple of hours to several days. Factors that are believed in the art to be responsible for the start-up period include the fabric being too thick, too open, or the surface of the new press fabric being too non-uniform. Over time, while the fabric becomes thinner, less open, more dense and smoother, the ability of the press fabric to appropriately extract water from the paper web increases until it reaches its optimum or steady state level.

Minimizing or eliminating the start-up period is a desired feature for a press fabric. Methods known in the art include pre-compacting the finished, needled press fabric, using finer (smaller denier) fibers on the surface or less batt within the base. However, none of these methods has been totally successful and there is a need in the art to develop a press fabric with reduced or no start-up time.

Forming a fine porous layer on or within a fabric in the production of a contemporary press

fabric is highly desirable. Formation of this surface characteristic has been previously attempted by a variety of techniques such as incorporating a foam layer or a fine nonwoven layer on or within the needle felt structure. Both of these techniques while desirable, have process drawbacks. Applying a foam layer requires wet chemistry application with careful control of foam density, penetration and substrate adhesion. Incorporating a nonwoven layer such as a meltblown or a spunbond layer requires careful attention to surface layer adhesion. If such a layer is placed within a structure subsequent needling of additional layers may disrupt porosity of the fabric.

Microfibers may also be formed on or incorporated within the surface of the fabric but microfibers of this type are difficult to process by conventional techniques. Further, the range of deniers that may be added to the fabric using conventional processing techniques may be limited, with increasing difficulty encountered under 10 microns in diameter.

Summary of the Invention

Accordingly, the present invention provides an anti-rewet press fabric which is in the form of an endless loop having an outer side and an inner side. A fine porous layer composed of split microfibers is applied to the outer side of the base fabric.

The present invention, unlike the prior art, provides a splittable fiber with extremely fine fiber cross-sections that allows for easy application on or within a fabric by conventional processes. Further, the present invention provides good anti-rewet

properties and exhibits a reduced startup period, controlled wear and near constant density.

The present invention will now be described in more complete detail with reference being made to the figures wherein like reference numerals denote like elements and parts, which are identified below.

Brief Description of the Drawing

Figure 1 is a perspective view of an anti-rewet press fabric in accordance with an embodiment of the present invention;

Figure 2 is a like view of an another embodiment in accordance with the present invention;

Figure 3 is a cross-sectional view in accordance with an embodiment the present invention;

Figure 4 is a like view in accordance with an embodiment of the present invention; and

Figure 5 is a photograph of splittable microfibers in accordance with the present invention.

Detailed Description of the Invention

A preferred embodiment of the present invention will be described in the context of a press fabric. However, it should be noted that the invention is applicable to other processes, such as industrial filtration fabrics. For example, fine splittable microfibers may be applied to the outer side or surface of an industrial filtration fabric. The fine porous layer offers high permeability and hence low pressure drops. Thus, higher filtration velocities may be applied resulting in a smaller required effective filtration surface. Further, the splittable microfibers of the present invention are able to filter fine, smaller sized particulates from liquid or gaseous fluid streams.

Turning now to the figures, Figure 1 is a schematic perspective view of press fabric 10 of the present invention. Press fabric 10 is of the on-machine-seamable variety and takes the form of an endless loop once its two ends 12,14 have been joined to one another at seam 16.

In an alternate embodiment, as shown in schematic perspective view in Figure 2, press fabric 20 has no seam and is in the form of an endless loop having an inner and outer surface.

In its simplest form, the anti-rewet fabric of the present invention includes a fine porous layer which may be applied to a base fabric. That is, the fine porous layer is disposed on, formed on or incorporated within a base fabric. The fine porous layer is composed of split microfibers which may be effectively split by needling or carding alone. Figure 3 illustrates such a fabric with fine porous layer 22 located on outer side or surface 26 of base fabric 24. In general, base fabric 24 is in the form of an endless loop having inner surface 25 and outer surface 26. Base fabric 24 may be woven, nonwoven, nonwoven arrays of MD or CD oriented yarns knitted or braided structure of yarns of the varieties used in the production of paper machine clothing, such as monofilament, plied monofilament and/or multifilament yarns extruded from polymeric resin materials. Resins from the families of polyamide, polyester, polyurethane, polyaramid and polyolefin resins may be used for this purpose. However, other materials for forming base fabric 24 would be readily apparent to a practitioner in this art and the selection of a

particular material would be within the purview of the skilled practitioner.

Base fabric 24 may alternatively be composed of mesh fabrics, such as those shown in commonly assigned U.S. Patent No. 4,427,734 to Johnson, the teachings of which are incorporated herein by reference. Further, base fabric 24 may be produced by spirally winding a strip of woven, nonwoven, knitted, braided or mesh material according to the methods shown in commonly assigned U.S. Patent No. 5,360,656 to Rexfelt et al., the teachings of which are incorporated herein by reference. Base fabric 24 may accordingly comprise a spirally wound strip, wherein each spiral turn is joined to the next by a continuous seam making base fabric 24 endless in a longitudinal direction. Base fabric 24 may also be endless, or on-machine-seamable.

As shown, base fabric 24 is woven from monofilament yarns in a single layer weave. Machine-direction yarns 28, which are the warp yarns in the base fabric 24 and cross-machine direction yarns 30 which are the weft yarns during the weaving of the base fabric 24, are, like the machine-direction yarns 28, shown to be monofilament yarns for the purposes of illustration. As is to be appreciated, other possible ways to form base fabric 24 would be readily be apparent to those so skilled in the art.

Fine porous layer 22 may then be applied to, or formed on, an outer side of the base fabric 24 as illustrated in Figure 3, or optionally to the inside as well, and constituent fibers thereof may be driven into the interior of base fabric 24 by needling. As is to be appreciated, other possible ways of applying

or forming fine porous layer 22 onto base fabric 24 would be apparent to those so skilled in the art, for example, melting, fusing or the like. Fine porous layer 22 is composed of splittable microfibers, which may be split during a carding and/or a needling process. Microfibers are fibers having a small average diameter of not greater than, for example, 12 microns. Microfibers having an average diameter from about 3 microns to about 8 microns are especially preferred. Suitable material for the microfibers include, for example, polyolefins, polyesters and polyamides. Especially preferred are microfibers comprising two different materials. Preferred materials include polyamides, such as nylon-6, nylon 33, nylon-11 and nylon 12, with nylon-6 or poly[imino(1-oxo-1,6-hexanediyl) being especially preferred. Other preferred microfibers are those made from polyethylene terpephthalates (PET). Especially preferred are microfibers comprising nylon-6 and PET, or polyester, with the fibers being present in a 1:1 ratio being most especially preferred.

In addition, as described in Figure 3, splittable microfibers applied to the surface or outer side of the press fabric may provide a smoother surface so that, in the course of passing through a press nip, sheet marking is reduced.

Although spilttable microfibers applied to, or formed on, the surface of a press fabric is preferred, the present invention is as aforesaid not so limited. For example, spilttable microfibers may be incorporated as an interior layer within the press fabric to provide a microporous anti-rewet layer.

For example, Figure 4 is another embodiment in accordance with the present invention. As shown, press fabric 10 includes base fabric 24, fine porous layer 22 and at least one additional layer 32. That is, one or more additional layer(s) 32 may be applied to, or formed on, an outer side 34 of fine porous layer 22 or, optionally to the inside of, any layer of press fabric 10. Layer(s) 32 may be composed of needled batt, a fine woven fabric or a non-woven structure. For example, needled batt may comprise staple fibers of any polymeric resin used in the production of paper machine clothing, but are preferably of a polyamide resin. As is to be appreciated, other possible ways to apply layer(s) 32 to fabric 10 would readily be apparent to one skilled in the art, for example, layer 32 may be applied or disposed between fine porous layer 22 and base fabric 24, and/or to the inside of base fabric 26.

Among the advantages of press fabric 10 are its good anti-rewet properties. Further, the press fabrics of the present invention may exhibit reduced start-up period and controlled wear.

Press fabric 10 may minimize rewet because the homogeneity of fine porous layer 22 permits less water to return to the paper web following exit from a press nip compared to the press fabrics of the prior art. The same uniformity of the pressing surface may maximize the dryness of the paper sheet following exit from the nip. Moreover, the fine, homogeneous, smooth porous layer makes press fabric 10 less prone to sheet blowing upon approach to a press nip. Further, controlled wear of the fibers compensates for the reduction of permeability caused

by clogging of the fabric during the startup period, that is, some microfibers may be composed of material selected to ensure that some of the fiber will be removed continuously or discontinuously during start-up. Accordingly fine porous layer 22 may provide optimum operation efficiency at start-up or minimize the start-up period.

Split microfibers of the present invention may be incorporated as a start-up aid in a press fabric on a tissue making machine. The split microfibers may be formed by passing fiber product, for example, T-512 manufactured by Fiber Innovation Technology, Inc. and commercially available, through a carding apparatus. As the commercial carding process is robust enough to split these fibers, quantities of fiber may be processed efficiently.

A fine porous layer composed of these split microfibers may be incorporated onto the surface of the press fabric as described in Figure 3. The fibers may be comprised of nylon-6 and PET, or polyester, and may have a denier of about 3 dpf. Figure 5 is a photograph of such fibers after carding that could be used on the surface of the fabric. At this denier, the fibers may be readily processed in a fabric by conventional processes and may exhibit excellent start-up. That is, the fine porous layer may provide optimum operation efficiency at start-up or minimize the start-up period. As mentioned above, pores formed by the fine microfibers retain water inside the press fabric without causing rewetting when the felt expands while exiting the press nip. At the same time, the extremely fine fibers provide a fabric surface which may result in optimum

distribution of the pressure against the paper web, thus improving paper quality and dewatering effects right from the beginning of fabric running or pressing.

Additionally, incorporating both nylon 6 and polyester or PET in the same splittable fiber, or in a side-to-side relationship, may allow for improved controlled wear rate, with the PET or polyester fibers disappearing first. That is, the PET or polyester fibers which are less abrasion resistant are successively worn off from the surface layer. This results in a fabric that maintains its relative density as it compacts, a concept as taught in commonly assigned U.S. Patent 4,882,217, which teachings are incorporated herein by reference. For this reason, these fibers are suitable for use in accordance with the invention, however, any other material or combination of materials suitable for this purpose as known to those skilled in the art may be used.

Furthermore, each layer containing the splittable microfiber may also contain nonsplittable fiber as well that is blended in as part of the carding process in amounts required to insure the integrity of the press fabric structure. The amounts of nonsplittable fiber sufficient to insure the integrity of the press fabric structure would be readily apparent to those so skilled in the art.

As mentioned above, the present invention is also applicable to industrial filtration fabrics. Filters have wide commercial applications and utility. Filters generally involve the use of a filter media, which, depending upon its construction

may or may not require a supporting structure or reinforcement means. For example, the filter media may be an industrial filtration fabric and the reinforcement means may be a wire made of metal or other suitable material formed into a desired shape.

Industrial filtration fabrics may be woven, non-woven, laminate, foam coated or coated with polymeric or metallic material having a high or low melting temperature depending upon the particular application, which is then possibly further processed by attaching a fibrous batt layer by needling.

One application of a filtration fabric is to remove particulate matter from a gas stream which flows from the outside of a filter into the filter with the particulate accumulated on the outside of the filter. The particulate may then be collected in a hopper at the base of the filter system. However, other applications of industrial filtration fabrics may be apparent to those so skilled in the art.

Such filter arrangements can be found in U.S. Pat. Nos. 5,951,726, and 6,706,085 the disclosures of which are incorporated herein by reference, where filter bags are described. As noted therein, such filters and their support members can be relatively large (i.e. 20-30 feet or more in length) depending upon the application. The bag is usually fabricated from any conventionally employed filter fabric conventionally used to filter solids entrained in a gas.

For example, needle punch filters may be used to remove particulate matter in bag houses. The preferred method of forming the fabric is to needle punch an assembly of layers together to provide a

plurality of points in which the fibers in the layers interlock to hold the layers and the assembly together without reducing the permeability of the composite.

Accordingly, fine splittable microfibers of the present invention may be applied to the outer side or surface of an industrial filtration fabric. Preferred materials for the microfiber include polyester. Needle punching or the like may be used to apply the fine splittable microfibers or to cause existing fibers in the fabric to split. However, any other method suitable for this purpose as known to those skilled in the art may be used. For example, a woven filtration fabric may be used for the filter media. The processing of yarns (twisting, weaving, etc.) may cause the fibers to spit, giving increased filtering area.

A fine porous layer including splittable microfibers offers high permeability and hence low pressure drops. Thus, higher filtration velocities may be applied resulting in a smaller required effective filtration surface. Further, the splittable microfibers of the present invention are able to filter fine, smaller sized particulates from liquid or gaseous fluid streams. In addition, the fine porous layer containing the splittable microfiber may also contain nonsplittable fiber.

Modifications to the above would be obvious to those of ordinary skill in the art, but would not bring the invention so modified beyond the scope of the appended claims